

Acceptance / performance verification test procedure for PMT

Preliminary – detailed procedure is being written.

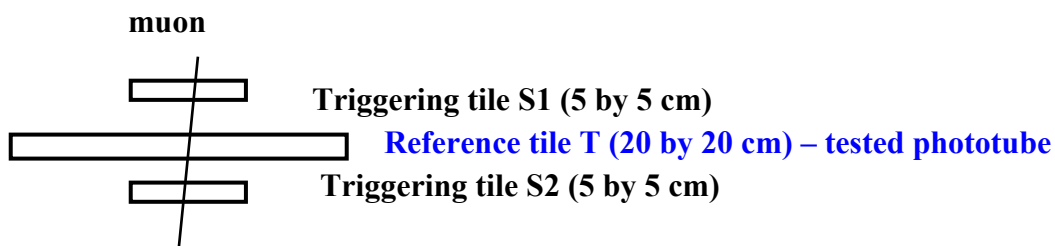
1. This test is to verify that the PMT survived shipping and to verify the basic performance parameters given in PMT data sheet.
2. The parameters to be tested are:
 - PMT sensitivity
 - PMT cathode conversion efficiency.

Both these parameters can be determined only in relative scale to be compared with data sheets. The absolute determination of these parameters requires equipment that is not available to us. The measurements described below are more directly related to our application.

3. The measurement approach.

The test utilizes the following:

- a reference scintillating tile, size not less than 20cm by 20 cm (to avoid possible edge effects), with WLS fiber bundle terminating in a PMT fitting.
- a pair of two 5cm by 5cm triggering scintillators, placed above and below the reference tile near the tile center, creating a vertical stack.
- Cosmic muons – to be used as the source of ionization in the scintillators
- PMT housing for the PMT under test
- Fixture with LED installed inside. This fixture should fit the PMT housing
- CAMAC readout
- 2 HVPS, pulse generator, oscilloscope, NIM logic crate, PMT preamplifiers, etc.



- 3.1. The sensitivity is measured by analyzing pulse-heights induced by the cosmic muons. The position of the PHA peak is considered to be a relative measurement of PMT sensitivity (the HV is kept the same for all these tests with a precision of $\pm 1V$). The sensitivity measured this way is proportional to the product of the actual PMT gain and the photocathode quantum efficiency.
- 3.2. The photocathode conversion efficiency (quantum efficiency) is determined from the PHA distribution of PMT signals induced by LED light pulses. It is assumed that the width of the

PHA distribution of LED-induced signals is determined only by fluctuation of the number of photoelectrons (p.e.). The number of p.e. can be retrieved from the PHA distribution:

$$N_{p.e.} = \left(\frac{P_{peak} - P_{ped}}{\sigma} \right)^2$$

From the LED test, the dependence $N_{p.e.}(P_{peak})$ can be determined, and consequently the number of photoelectrons created by cosmic muons can be estimated (which is directly related to quantum efficiency, assuming an equal amount of light created by muons in the same tile, with the same fiber-PMT coupling technique).

4. Qualification PMT test results:

PMT serial number	Datasheet Sensitivity	Measured Sensitivity, relative units	Measured Q.E., relative units	Measured S/QE	Datasheet Gain	Measured S/QE /Datasheet Gain	Datasheet Q.E.
ZL 0609	396	0.65			6.19		16.0
ZL 0610	656	0.88	0.79	1.11	10.40	0.106	15.4
ZL 0879	644	0.71	0.78	0.91	8.66	0.105	16.9
ZL 0880	748	0.81	0.80	1.01	10.14	0.100	16.4
ZL 0882	554	0.69			7.91		16.0
ZL 0883	633	0.87	1.00	0.87	9.11	0.095	16.8
ZL 0885	425	0.57	0.80	0.71	6.42	0.111	16.1
ZL 0896	684	0.92	0.90	1.02	10.07	0.101	17.6
ZL 1085	707	0.81	0.71	1.14	11.44	0.100	15.2
ZL 1088	191	0.35	0.80	0.44	3.00	0.147	15.0

